

CLAIMS

I/We claim:

- [c1] 1. A method for removing material from a microfeature workpiece, comprising:
- contacting a polishing pad material with a portion of a microfeature workpiece having a doped silicon material;
- disposing a polishing liquid between the doped silicon material and the polishing pad material, the polishing liquid including a surfactant;
- moving at least one of the microfeature workpiece and the polishing pad material relative to the other while the microfeature workpiece contacts the polishing pad material and the polishing liquid; and
- uniformly and simultaneously removing at least some of the doped silicon material from regions of the microfeature workpiece having different crystalinities and/or different doping characteristics by contacting the doped silicon material with the surfactant in the polishing liquid as at least one of the microfeature workpiece and the polishing pad material moves relative to the other.
- [c2] 2. The method of claim 1, further comprising inhibiting a chemical interaction between the doped silicon material and the polishing liquid by contacting the surfactant with the polishing liquid.
- [c3] 3. The method of claim 1, wherein uniformly and simultaneously removing at least some of the doped silicon material includes uniformly and simultaneously removing at least some of the doped silicon material from regions having different crystal orientations.

- [c4] 4. The method of claim 1, wherein uniformly and simultaneously removing at least some of the doped silicon material includes uniformly and simultaneously removing at least some of the doped silicon material from regions having different levels of amorphousness.
- [c5] 5. The method of claim 1, wherein uniformly and simultaneously removing at least some of the doped silicon material includes uniformly and simultaneously removing at least some of the doped silicon material from regions having different dopant concentrations.
- [c6] 6. The method of claim 1 wherein disposing a polishing liquid includes disposing a polishing liquid having a generally non-ionic surfactant, and wherein the method further comprises adhering the generally non-ionic surfactant to the doped polysilicon.
- [c7] 7. The method of claim 1, further comprising controlling a temperature of an environment in which the polishing process takes place to be up to about 125 degrees Fahrenheit.
- [c8] 8. The method of claim 1 wherein moving at least one of the microfeature workpiece and the polishing pad material relative to the other while the microfeature workpiece contacts the polishing pad material and the polishing liquid includes reducing the formation of defects in the doped silicon material when compared with a polishing liquid that does not include the surfactant.
- [c9] 9. The method of claim 1, further comprising disposing the surfactant in the polishing liquid while the polishing liquid is in contact with the polishing pad material.

- [c10] 10. The method of claim 1 wherein removing at least some of the doped silicon material includes removing defects in the doped silicon material, and wherein the method further comprises forming the defects in the doped silicon material before uniformly removing at least some of the doped silicon material.
- [c11] 11. The method of claim 1 wherein removing at least some of the doped silicon material includes removing pit defects in the doped silicon material, and wherein the method further comprises forming the pit defects in the doped silicon material before uniformly removing at least some of the doped silicon material.
- [c12] 12. The method of claim 1 wherein removing at least some of the doped silicon material includes removing at least some of the doped silicon material from a filled recess.
- [c13] 13. The method of claim 1 wherein removing at least some of the doped silicon material includes removing polysilicon doped with phosphorous.
- [c14] 14. The method of claim 1 wherein disposing a polishing liquid includes disposing a polishing liquid that includes about 0.3% to about 1.0% surfactant by weight, the surfactant being generally non-ionic.
- [c15] 15. The method of claim 1 wherein disposing a polishing liquid includes disposing a polishing liquid that includes from about 0.001% to about 1.0% surfactant by weight, the surfactant being generally non-ionic.
- [c16] 16. The method of claim 1 wherein the microfeature workpiece has a surface with an aperture and wherein the doped silicon material is disposed in the aperture, further wherein the microfeature workpiece includes a layer of a material between the surface and the doped silicon material, and wherein the method

further comprises removing the layer of material by contacting the layer of material with the polishing pad material and the polishing liquid.

[c17] 17. The method of claim 1 wherein the microfeature workpiece has a surface with an aperture and wherein the doped silicon material is disposed in the aperture, and wherein the microfeature workpiece includes a stop layer between the surface and a portion of the doped silicon material external to the aperture, and wherein the method further comprises ceasing to remove material from the microfeature workpiece when the stop layer contacts the polishing pad material.

[c18] 18. The method of claim 1 wherein disposing a polishing liquid includes disposing a polishing liquid having a surfactant with a non-zero ionicity.

[c19] 19. The method of claim 1 wherein disposing a polishing liquid includes disposing a polishing liquid having a surfactant with a CAS registry number of 9004-95-9.

[c20] 20. The method of claim 1 wherein disposing a polishing liquid includes disposing a polishing liquid having a polyoxyethylene ether surfactant.

[c21] 21. The method of claim 1 wherein disposing a polishing liquid includes disposing an alkaline polishing liquid.

[c22] 22. The method of claim 1 wherein disposing a polishing liquid includes disposing a polishing liquid that includes at least one of potassium hydroxide, sodium hydroxide, tetramethyl ammonium hydroxide and piperazine.

[c23] 23. The method of claim 1, further comprising adhering the surfactant to the doped silicon material.

[c24] 24. The method of claim 1 wherein removing at least some of the doped silicon material includes removing doped amorphous silicon.

[c25] 25. The method of claim 1 wherein removing at least some of the doped silicon material includes removing doped polysilicon.

[c26] 26. A method for removing material from a microfeature workpiece, comprising:

contacting a polishing pad material with a portion of a microfeature workpiece having a doped silicon material;

disposing a first polishing liquid between the doped silicon material and the polishing pad material;

moving at least one of the microfeature workpiece and the polishing pad material relative to the other while the microfeature workpiece contacts the polishing pad material and the first polishing liquid to remove at least a portion of the doped silicon material at a first rate;

disposing a second polishing liquid between the doped silicon material and the polishing pad material, the second polishing liquid having a surfactant;

uniformly and simultaneously removing at least some of the doped silicon material from regions of the microfeature workpiece having different polycrystalline crystalinities, and/or different doping characteristics, at a second rate slower than the first rate by contacting the doped silicon material with the surfactant in the second polishing liquid.

[c27] 27. The method of claim 26, further comprising forming the second polishing liquid by disposing the surfactant in the first polishing liquid.

- [c28] 28. The method of claim 26, further comprising:
forming defects in the doped silicon material while moving at least one of
the microfeature workpiece and the polishing pad material relative to
the other with the microfeature workpiece contacting the polishing
pad material and the first polishing liquid; and
removing the defects in the doped silicon material by moving at least one of
the microfeature workpiece and the polishing pad material relative to
the other with the microfeature workpiece contacting the polishing
pad material and the second polishing liquid.
- [c29] 29. The method of claim 26 wherein disposing a second polishing liquid
includes disposing a second polishing liquid having a generally non-ionic
surfactant, and wherein the method further comprises adhering the generally non-
ionic surfactant to the doped silicon material.
- [c30] 30. The method of claim 26 wherein disposing a second polishing liquid
includes disposing a second polishing liquid that includes from about 0.001% to
about 1.0% surfactant by weight, the surfactant being generally non-ionic.
- [c31] 31. The method of claim 26 wherein the microfeature workpiece has a
surface with an aperture and wherein the doped silicon material is disposed in the
aperture, further wherein the microfeature workpiece includes a layer of a material
between the surface and a portion of the doped silicon material external to the
aperture, and wherein the method further comprises removing the layer of
material by contacting the layer of material with the polishing pad material and the
second polishing liquid.
- [c32] 32. The method of claim 26 wherein the microfeature workpiece has a
surface with an aperture and wherein the doped silicon material is disposed in the
aperture, and wherein the microfeature workpiece includes a stop layer between

the surface and a portion of the doped silicon material external to the aperture, and wherein the method further comprises ceasing to remove material from the microfeature workpiece when the stop layer contacts the polishing pad material.

[c33] 33. The method of claim 26 wherein disposing a second polishing liquid includes disposing a second polishing liquid having a surfactant with a CAS registry number of 9004-95-9.

[c34] 34. The method of claim 26, further comprising inhibiting a chemical interaction between the doped silicon material and the second polishing liquid by contacting the surfactant with the second polishing liquid.

[c35] 35. The method of claim 26 wherein uniformly and simultaneously removing at least some of the doped silicon material includes uniformly and simultaneously removing at least some of the doped silicon material from regions having different levels of amorphousness.

[c36] 36. The method of claim 26 wherein uniformly and simultaneously removing at least some of the doped silicon material includes uniformly and simultaneously removing at least some of the doped polysilicon from regions having different dopant concentrations.

[c37] 37. A method for removing material from a microfeature workpiece, comprising:

contacting a first polishing pad material with a portion of a microfeature workpiece having doped silicon material;

disposing a first polishing liquid between the doped silicon material and the first polishing pad material;

moving at least one of the microfeature workpiece and the first polishing pad material relative to the other while the microfeature workpiece

contacts the first polishing pad material and the first polishing liquid to remove at least a portion of the doped polysilicon at a first rate; contacting a second polishing pad material with the microfeature workpiece; disposing a second polishing liquid between the doped silicon material and the second polishing pad material, the second polishing liquid having a surfactant; and simultaneously and uniformly removing at least some of the doped silicon material from regions of the microfeature workpiece having different crystalinities and/or different doping characteristics, at a second rate slower than the first rate by contacting the doped silicon material with the surfactant in the second polishing liquid.

[c38] 38. The method of claim 37, further comprising moving the microfeature workpiece from a first apparatus having the first polishing pad material to a second apparatus having the second polishing pad material.

[c39] 39. The method of claim 37, further comprising:
forming defects in the doped silicon material while moving at least one of the microfeature workpiece and the first polishing pad material relative to the other with the microfeature workpiece contacting the first polishing pad material and the first polishing liquid; and
removing the defects in the doped silicon material by moving at least one of the microfeature workpiece and the second polishing pad material relative to the other with the microfeature workpiece contacting the second polishing pad material and the second polishing liquid.

[c40] 40. The method of claim 37 wherein disposing a second polishing liquid includes disposing a second polishing liquid that includes from about 0.001% to about 1.0% surfactant by weight, the surfactant being generally non-ionic.

- [c41] 41. A method for removing material from a microfeature workpiece having a doped silicon material, comprising:
- forming defects in the doped silicon material of the microfeature workpiece by disposing a first polishing liquid adjacent to the doped silicon material and removing a first portion of the doped silicon material by chemical-mechanical planarization, the first polishing liquid having a first composition; and
- disposing a second polishing liquid adjacent to the doped silicon material and removing a second portion of the doped silicon material and the defects by chemical-mechanical planarization, the second polishing liquid having a second composition different than the first composition.
- [c42] 42. The method of claim 41 wherein removing the first portion of the doped silicon material includes removing the first portion at a first rate and wherein removing the second portion of the doped silicon material includes removing the second portion at a second rate, the second rate being less than the first rate.
- [c43] 43. The method of claim 41, further comprising forming the second polishing liquid by disposing the surfactant in the first polishing liquid.
- [c44] 44. The method of claim 41 wherein disposing a second polishing liquid includes disposing a second polishing liquid that includes a surfactant.
- [c45] 45. The method of claim 41 wherein disposing a second polishing liquid includes disposing a second polishing liquid that includes from about 0.001% to about 1.0% surfactant by weight, the surfactant being generally non-ionic.

[c46] 46. The method of claim 41 wherein removing the second portion of the doped silicon material includes uniformly removing the second portion of the doped silicon material from regions of the microfeature workpiece having different crystalinities and/or different doping characteristics.

[c47] 47. The method of claim 41 wherein removing the second portion of the doped silicon material includes uniformly and simultaneously removing the second portion of the doped silicon material from regions having different levels of amorphousness.

[c48] 48. The method of claim 41 wherein removing the second portion of the doped silicon material includes uniformly and simultaneously removing the second portion of the doped silicon material from regions having different dopant concentrations.